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Regional Meeting for the Initiation
of a Regional Network for Microelectronics
in the ECLAC Region (REMLAC)*

Caracas, Venezuela, 3-7 June 1985

APPROACH TO REGIONAL MICROELECTRONICS CO-OPERATION PROGRAMME**

Prepared by

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* Co-sponsored by SELA/ECLAC.

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I. Observations on Brazilian Electronic Industry

In 1983, the Brazilian electronic equipment production reached $ 3.7 billion, which originated a demand of $ 190 million in the semiconductor sector.

In order to supply this internal demand, 17 semiconductor manufacturers have produced $ 130 million, of which $ 28 million for exports. This required the importation of $ 26 million of inputs. Additionally, imported finished semiconductors amounted to $ 90 million.

Recently, equipment design has been strongly affected by the increasing trend of IC technology to integrate more and more functions in a single chip. As a result, equipment design is progressively merging with chip design.

As the Brazilian electronic industry does not master the highly complex know-how in the semiconductor sector (from design to marketing), its trend has been to become more dependent, mainly due to the increasing use of custom-made ICs in modern systems.

In 1983, the ten largest world-wide semiconductor manufacturers have reached sales of $ 9.5 billion, i.e. 55 percent of the world market. Four of them have sold more than $ 1 billion. Only Texas and Motorola have produced more than $ 3 billion, this is 16 times bigger than the Brazilian market.

The Brazilian industry has faced great difficulties in trying to implement the complete semiconductor production cycle. Among these difficulties, we have:

- the lack of industrial scale for mass-production equipment;
- the large diversity in semiconductors types and quantities, partially due to the different origins of equipment designs locally manufactured;
- the lack of up-to-date technology;
- the limited skilled human resources.

The semiconductor industry is capital intensive and even a small industrial unit requires high investment. Marketing practices of the big

multinational manufacturers - consisting in producing in huge volumes for the world market and in introducing a constant flow of new products at very low prices - make it difficult for a local manufacturer of standard products to achieve the industrial scale required for the feasibility of a local complete production cycle.

Today, the microelectronic field presents one of the quickest technological evolutions. High investments may become obsolete in a short period, without being paid off. In many cases, companies not able to follow this evolution have been absorbed by others, in order to avoid more dramatic solutions.

Although Brazil has several nuclei of specialists in R and D centres and industry, they are in a limited number and work with insufficient financial resources. So, it has been impossible for us to cope with the high technology internationally available and therefore our production does not reach the world market competitively.

However, the world-wide trend of using more customized ICs for big production series of equipment and semicustomized ICs being economically feasible for smaller series, opens a new perspective enabling the industries from developing countries to design and produce microelectronic components for their needs. So, we can develop a high technology activity and a complete production cycle, enabling our local microelectronic industry to become internationally competitive in many market segments.

But the development of these devices will require high technological capabilities in design methodologies and in computer-aided design tools.

A regional co-operation programme will enable developing countries to develop, in the productive area:

- new methodologies and production processes;
- inputs development and manufacturing;
- acquisition, improvement, design and production of machinery and tools;
- training of skilled human resources.

Regional co-operation can also be a manner of increasing the number and the results of the research centres' developments, as well as local developments through an R and D programme organized on a regional level, avoiding redundant efforts. It should also be stressed that the exchange among researchers and technicians will speed up the work at these centres.

Countries which have similar technological levels can implement an effective co-operative programme in human resources development. This will certainly be the quickest and most economical way to enhance their skills in this high technology field, leading to a socio-economic development less dependent on developed countries. A regional co-operation programme should also establish the joint operation of inputs and finished semiconductors industries, in order to reduce the production costs.

II. Approach to a Regional Microelectronics Co-operation Programme

A. Industry

(1) Projects concerning microelectronic elements

Centralization of the production processes and the decentralization of design is the industrial trend in modern microelectronics. Microcircuit quality results as much from the production equipment as from design tools, and both should be constantly optimized and updated. Therefore within three years Brazil will need five times more qualified human resources specialized in hardware, software, documentation and communication systems. It constitutes a necessary condition to improve the efficiency of existing project groups in Brazil.

In the field of microelectronics regional co-operation could be most useful in promoting development of an integrated system project in the countries of the region.

. This co-operation would be aimed at forming a critical mass of microelectronic semi-custom and full-custom projects. It includes specifications, measuring and testing for integrated circuits.

. A critical mass of developers of CAD tools for testing of gate-arrays, integrated circuits, standard cells and full-custom digital and analogue circuits.

. Integrated circuit projects that may be disseminated to an increasing number of users at competitive prices.

. Research programmes for improving CAD tools for integrated circuits.

. Execution of production processes in the region, together with the implementation of locally developed processes.

. Creation of a regional project station with a complete ICs cells library interconnected through communication means (DATA TX) to the various domestic low-cost project stations in order to process a substantial part of the programmes necessary to each project.

This goal could be attained through the following activities:

- Software and hardware standardization to allow for the communication and portability of programmes being used.

- Project and design methods established pursuant to domestic and/or foreign procedures.

- Software professional documentation and libraries necessary to the project.

- The search for persons who have already proposed, created, prepared, characterized and evaluated new structures or materials.

- Availability of courses.

(2) Final Product

Domestic companies, as SID MICROELECTRONICA, HELIO DINAMICA, AEGIS AND ITAU COMPONENTES can be interested in creating a technological co-operation programme and a products and inputs industrial completion programme for their production, i.e.:

- production equipment (diffusion and assembly)
- production processes
- quality control (reception, production processes and tests)
- personnel training
- MASKS manufacture and supply
- Chips diffusion and supply
- final product supply (to complete the marketing supply line)

(3) Inputs

(a) Electronic grade silicon

The R+D centres and the Brazilian industry are able to co-operate with industries abroad by supplying technology and training human resources in the fields of:

- Metallurgic grade silicon
- Trichlorosilane
- Polycrystalline silicon
- Monocrystalline silicon
- Cut and/or polished wafers (for solar cells production)

(b) Silicon wafers

The Brazilian industry needs highly resistant wafers obtained from monocrystalline silicon produced by float zone method for I.C. diffusion. Two million dollars are deemed necessary for producing 300 000 wafers with 75-100 mm diameter.

(c) Photomasks

Photomasks are scarcely used in Brazil. The small quantity used is economically not viable. It should be considered, however, as a strategic need for implementing the semiconductor projects developed locally.

Taking into account the production scope of Brazilian and Latin American industries, one single photomasks generation centre would meet the needs of local industry to LSI ICs level. A plant like that could copy working photomasks. With the existing designs made by the R&D laboratories of industries it could also prepare photomasks.

Other systems could be installed at a later stage in semiconductor devices industries.

- High grade purity metal
- Thin wires and wires for evaporation

Gold and aluminium ultra-thin wires are used to some extent in Brazil. In 1982, the assembly and manufacture industries used three million metres of golden wire (diameter 25, 50 and 75 micron) and three hundred thousand metres aluminium wire (25 micron). 80 micron golden wire is manufactured by a Brazilian industry and will soon be entering the market.

Since refining and shaping of microwires is already performed in Brazil, the industrial scale to be reached through regional co-operation (the implementation of a manufacturing system - 500 000 dollar investment) for that purpose seems feasible.

(d) Frames and cases

The high aggregate value for the final product costs and relatively low investment as well as global market opportunity make the manufacture of lead frames and cases the most economic product for the microelectronic industry.

In order to increase industrial scale of production and reduce costs, the number of different lead frames geometry should be reduced and metal alloys production should encouraged.

Three companies are operating in Brazil aiming at that purpose. Experts have estimated that 250 000 dollars would be necessary for development of metal alloys and plates.

Brazilian industry can supply progressive stamp tools for the manufacture of lead frames.

(e) Chemistry products

The electronic chemistry industry has not been developed enough for high grade production and has no R&D capabilities.

Initially, it would be necessary to refine at electronic level the organic acids and solvent. Those are mostly used in local industry. At a later phase photoresistants, dopants, gases and other products are to be produced.

(f) Epoxies and silicons

These products have great economic significance and need highly sophisticated technology. The Brazilian chemical industries do not reach electronic grade quality in these products:

- Metallized clay capsule
- Desoxide super cover and bases for semiconductors
- Quartz tube for diffusion

These inputs are not manufactured in Brazil.

Other industrial programmes could be implemented in the form of regional co-operation:

- Industrial production technique programme on microelectronics: aimed at exchanging and creating new industrial production techniques, moving the industry and R&D efforts for developing basic techniques for the implementation of new products and methods.

- Checking and quality guarantee techniques development programme: aimed at disclosing quality guarantee techniques for microelectronic methods and products.

- Microelectronic equipment and tools programme: aimed at improving and developing new equipment and tools for microelectronics. Industries, R&D agencies and universities should be encouraged to participate in this programme.

- Microelectronic metrology programme: manufacturing projects and methods characterization is a basic factor for microelectronic quality and product control.

B. Research and development

(1) R&D at the university

The main hindrance consists of the significant limitation of qualified personnel. A great effort should be made towards training human resources at the university. The exchange with foreign institutions is a basic factor to speed up their education on the appropriate level. Research should stress education rather than production. Research problems should be updated in order to enable the students to perform and/or follow up the most advanced world developments.

(2) R&D institutes

International and regional co-operation is a basic factor for achieving good results in a given area. Investments in the most advanced technological research activities should not be granted for the purchase of sophisticated equipment. It should be a result of a natural evolution of research activities. Group activities should be encouraged, especially on MOS Bipolar 12 L, thin and thick films, quantic optics, epitaxial growing, ion implantation technology, and on research in raw material and development of new methods for electrical measures.

Particular attention should be devoted to research for the industrial consolidation of technology using 1,5-2μm geometry for mid-term microstructures and 1μm for long-term ones, as well as the creation of project capability programmes as well as the manufacture and characterization of power devices.

(3) R&D in industry

Industries should perform R&D work related to all products intended to be manufactured on an industrial basis.

The R&D effort should concentrate, then, on the technology used by industry itself.

The semiconductor companies should perform R&D work especially on:

- Devices projects
- New project techniques
- New production techniques
- Quality control and default analysis methods
- New assembly systems and methods
- Testing and test methods criteria

A regional co-operation programme with the purpose of assisting the implementation of R&D in companies would be most desirable.

C. Human resources

In 1982 Brazil had 335 microelectronic specialists; 42 on graduate level. This number is extremely low if compared with the 8 000 microelectronics experts of BELL LABORATORIES (USA).

The remaining 293 experts concentrate their activities on packing and test phases. A few have some experience on circuits diffusion and conception phases. At industrial level, circuit diffusion and conception is practically unknown in Brazil, except by a small group working at SID SEMICONDUCTORS.

The requirements for the next five years comprise 35 method experts and 100 project experts at the R&D centres as well as 240 experts for the universities.

Other supporting activities (industrial engineering, maintenance, quality control etc.) will also require technical qualification. Industry would require 50 experts graduated on methods and 200 experts graduated on projects. Our present capacity to train human resources at this level is inadequate.

The lack of human resources, investments and limited time turn this programme into a task that can be accomplished only with extensive regional and international co-operation.

Visiting professors should be invited to give courses at the existing centres and a post-graduate programme abroad should be implemented.

Regional co-operation for obtaining human resources could be made at the following levels:

- Technical
- Graduate
- Post-graduate

Technical and graduate levels would have two basic purposes: the education of experts for production and selection of new researchers who would be further educated .

Subjects should relate to special topics as materials engineering, microelectronics, solid state physics, chemistry, metallurgy etc.

Post graduate education should result in high qualifications as researchers, professors and technicians to work in the various sectors of microelectronics.

In view of the lack of human resources and in order to obtain higher efficiency, specialization of educational centres existing in several countries of the region would be advisable.

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Regional Meeting for the Initiation of a Regional Network for Microelectronics in the ECLAC Region (REMLAC)*

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REPORT**

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INTRODUCTION

1. The regional meeting for the initiation of a regional network for microelectronics in the ECLAC region (REMLAC) was held at Caracas from 3-7 June 1985. It was organized by UNIDO and co-sponsored by SELA and ECLAC. The list of participants and the list of documents prepared for the meeting are in Annexes I and II. Mr. P. Esqueda (Venezuela) was elected as Chairman, and Mr. W. Oliver (Jamaica) as Rapporteur.

2. The background to the meeting was as follows: The UNIDO/ECLA expert group meeting on the implications of microelectronics for the ECLA region, held in June 1982 in Mexico D.F., recommended that a Latin American programme of co-operation in microelectronics should be initiated. It also spelt out several elements of action which should go into the programme. Similar activities were also identified as elements of a Latin American Programme of Co-operation which was recommended by the second meeting of high-level governmental experts in the field of science and technology, held by the Latin American Economic System (SELA) in May 1984, later supported by the Tenth Regular Meeting of the Consejo Latino Americano of SELA in October 1984 (Decision 200). A UNIDO mission of experts which visited Venezuela in connection with a request by the Venezuelan Government recommended the organization of a regional network for microelectronics as an instrument through which the elaboration and implementation of co-operative programmes can be effected and as components of which national and regional nodes could function. Subsequently, a two-member expert mission was organized by UNIDO during February/March 1985. Its members exchanged views with policy-makers and technologists in Mexico, Venezuela, Brazil and Argentina. The mission found keen interest in the initiation of the network in the countries visited.

3. Based on the foregoing elements, the meeting was convened, attended by representatives nominated by a selected number of countries in the region, with the view to establish the network on a pilot basis, to provide a framework for co-operation in which other countries in the region may join and to develop a programme of activities of co-operation for the coming years.

4. Before the meeting commenced its work, statements were made by Ambassador S. Alegrett, Permanent Secretary of SELA, Dr. C. Daza Ramirez, Director General of the Office of the Minister of State for Science and Technology, Venezuela, the Special Technical Adviser to the Technology Programme of UNIDO and Mr. J. Izcue, Director, Washington Office of ECLAC. In these statements interest was expressed on behalf of the respective organizations in the creation of the network and in supporting it with a view to strengthening technological capabilities in microelectronics in the region and increasing its self-reliance in this field.

5. The report of the meeting, including the conclusions and recommendations, was adopted on 7 June 1985.

I. CONCLUSIONS AND RECOMMENDATIONS

A. Structure of REMLAC

6. The country representatives agreed that the institutions indicated by their governments in sub-para. (e) below shall perform functions as the Regional Network for Microelectronics for Latin America and the Caribbean (REMLAC) on the following basis:

(a) The network is established on a pilot, inter-institutional basis from 7 June 1985 for a period of six years or until it acquires an intergovernmental personality, whichever is earlier;

(b) The overall objective of the network is to carry out joint activities with the aim of strengthening technological capabilities in microelectronics in the participating countries individually and collectively, in order to apply the technology for meeting their specific needs;

(c) Participation in the network is open to all countries in the Latin American and Caribbean region. The following countries represented in the meeting will be the initial members, i.e. Argentina, Brazil, Cuba, Guatemala, Jamaica, Mexico, Peru and Venezuela. The meeting called upon other countries in the region to join the network;

(d) The network will comprise of, and operate through, national nodes, (i.e. national centres or groups) in the member countries. There will be only one node per country acting as the focal point and other local entities should link up to the network through the national node. National nodes may have different functional characteristics, but typically would include R+D and applications capabilities;

(e) Representatives from some of the participating countries have indicated their national nodes as follows:*/

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*/ Annex III contains the addresses and, where indicated, the name of the contact person for each node.

Argentina:	National Electronics Programme, Subsecretariat of Informatics and Development
Brazil:	Instituto de Microelectronica do Centro Technologico para Informatica
Cuba:	Centro Científico Técnico
Guatemala	Bank of Guatemala (in the first instance)
Jamaica:	National Computer Centre
Mexico	Instituto de Investigaciones Eléctricas (in the first instance)
Peru:	Instituto Nacional de Investigación Technológica Industrial y Normas Técnicas (ITINTEC)
Venezuela:	Fundación Instituto de Ingeniería.

In the course of its operation, the network will recognize as regional nodes national institutions in participating countries which can function as regional centres of excellence.

(f) The functions of the network will be:

(i) Periodical meetings with substantial technical scope (approximately once in eighteen months) for review and evaluation of the network activities and for agreeing upon new programmes. The meetings will also include discussion and exchange of experience on specific subjects of common interest. The country in which the meeting is held will bear the local cost, while the travel cost of representatives of other participating countries will be borne by the respective countries. UNIDO, SELA and ECLAC are requested to support such meetings; and

(ii) Joint activities of (i) a general character such as exchange of information and studies and (ii) a specific character, such as R+D, training and industrial co-operation which may be undertaken by two or more members of the network.

(g) Indicative programme areas of network activities are contained in Section B below. Activities will be carried out only to the extent that funds are available. The UNDP is requested to finance the specific technical assistance needs of the countries and network activities including preparatory assistance in 1986. Until such time as the network attains a juridical personality the programme of activities will be implemented through one or more projects executed by UNIDO. To carry out the above-mentioned projects UNIDO will take into account the programme of work in microelectronics of ECLAC and the relevant decisions of the Consejo Latino Americano of SELA, and could also request the co-operation of SELA.

(h) The activities of the network would be funded through different sources, such as:

(i) Voluntary contributions in national currency by Member States are expected for activities of relevance to the network, and in addition funding of national activities of relevance to the network by external funding sources;

(ii) Financing by funding agencies of the activities through one or more projects;

(iii) Funding of activities by international organizations.

(i) Funding agencies, in particular the Inter-American Development Bank (IDB) and the World Bank are invited to fund specific projects proposed by the network. UNIDO and other international organizations are requested to support the implementation of joint activities of the network on request, in accordance with the established procedures.

(j) The projects formulated to carry out the activities of the network will have a detailed chapter explaining their financing.

(k) UNIDO as the promoter of the network is called upon to support it through technical assistance, advisory services and promotional activities in the participating countries.

(l) The nodal point of the country which hosts a meeting of the network will perform the secretariat functions of the network until they are taken over by the nodal point of the country which hosts the next meeting. The Fundación Instituto de Ingeniería, being the node of Venezuela, will perform secretariat functions until the next meeting of the network. The secretariat will:

(i) receive notifications of participation in the network by other countries in the region;

(ii) circulate information pertinent to network activities; and

(iii) participate, when required, in preparatory activities for the formulation of the programme of work of the network.

UNIDO, in co-operation with SELA and ECLAC, is requested to assist the network secretariat as appropriate. The network will develop and use links with existing regional and subregional organizations within the region and also with the appropriate organizations outside the region.

B. Indicative Programme Areas for Network Activities under REMLAC

7. Indicative programme areas for network activities are presented in broad outlines in five modules. Specific network activities will be elaborated subsequently in the form of one or more projects. In such elaboration the following considerations should be kept in mind:

(a) The need for selectivity and substantial impact;

(b) The modules would not necessarily require equal resources;

(c) It is not necessary for each participating country to participate in all activity modules. Where it does participate, the complementary actions necessary at the national level should be carried out;

(d) The activities of the network are envisaged in two phases, i.e. (1985-1986 and 1987-1991). The activities of the modules span both phases, it being understood that all necessary preparatory work should be completed in the first phase and, where possible, substantive activities also carried out in the first phase itself;

(e) Projects will essentially finance network activities and the additionality required for extending a network activity into an inter-country one.

Information exchange

8. (a) Activities of information exchange in which all member countries will participate. The national focal points will make efforts to collect such information from within their countries and supply it to other members:

(i) Circulation of reports of national activities by focal points;

(ii) Collection and dissemination and information relating to production and supply of raw materials, components and equipment from within the participating countries;

(iii) Inventory of training and educational courses in microelectronics in participating countries;

(iv) Inventory of experts in all aspects of microelectronics technology and industry in participating countries; and

(v) Inventory of expatriate Latin American experts in all aspects of microelectronics technology and industry.

(b) Generation and use of information relevant to other programme area modules. The countries participating in each programme area module will make efforts to collect the information for the formulation and conduct of specific network activities;

(c) Collection and analysis of information pertinent to future network activities, e.g. pooling and analysis of information relating to technology development and production of rural telephone exchange systems in participating countries. The participating countries are requested to supply the information to other members of the network;

(d) Participating countries which have established groups or mechanisms to monitor technology and market trends will each monitor selected aspects of those trends and exchange the information. External consultants and sources of information will be utilized as necessary. The information collected should be suitable for answering real and practical questions of actual concern to the participating countries.

Improvement of the capability for design of custom and semi-custom hybrid and monolithic ICs and other semiconductor devices and printed circuits

9. Activities will be carried out within a total context which will cover (a) establishing or strengthening national centres for design; (b) regional co-operation in design; (c) access to silicon foundries outside the region; and (d) establishment of and access to silicon foundry facilities within the region. The aim is to increase the number of designers in each participating country at least fivefold in three years.

10. An important activity of the network, which is emphasized as a priority, is a project for the manufacture of a multi-project chip at a silicon foundry to be selected. Such a chip would consist of a series of circuits of interest to each country, designed by their respective design groups. This requires that each of the participating countries possesses or develops, through regional co-operation, a capacity for the design of highly complex integrated circuits and also agrees on design tools and rules, time schedules, testing procedures etc. Each of the participating countries would finance its own infrastructure but activities such as training and meetings necessary for the design activities, and fabrication, testing and dissemination will be carried out as a network project.

11. In addition to the multi-project chip a programme of co-operation among design centres will be developed and promoted with a view to increasing interaction among designers and carrying out common design projects.

Establishment and strengthening of the semiconductor manufacturing capacity of the region

12. The network activities will aim to improve personnel training in the already existing R+D laboratories and university entities.

13. The network activities will also aim at the establishment and strengthening of facilities which are capable of acting as foundries for the region so as to create a regional capability in this respect.

Application of microelectronics

14. Surveys of national and regional application possibilities will be carried out in one or more of the following sectors, such as capital goods, petroleum refining, telecommunication, electricity, transport, agro-industries, ready-made garments, leather, agriculture and education. Surveys will be carried out by the personnel of each participating country on a format to be agreed upon by all participating countries and with the assistance of external experts as necessary. Training for carrying out such surveys will be an integral part of the programme.

15. Feasibility studies will be conducted by inter-country consultancy groups for manufacturing units in selected sectors and for software and systems houses.

16. Co-operative activities will be carried out in setting up or strengthening microprocessor application centres, their application interests identified and co-operative activities undertaken including the development of software, the testing of prototypes and commercialization of products developed. The respective countries will be responsible for the establishment and operation of the microprocessor application centres. Co-operative activities may be funded through network projects. Training should be an integral part of these activities.

Acquisition and use of hardware and software

17. A specific aim of the network activities will be to strengthen negotiating capabilities in the acquisition of hardware and software in particular through co-operation in conducting training workshops; the collection and consolidation of training material; identification of institutional facilities for training in participating countries; and training of trainers.

18. Advisory services will be provided among member countries on maintenance and optimization of use of existing computer facilities.

C. Follow-up

19. National focal points will circulate information to each other on their national activities at least once in six months.

20. National focal points will inform the network secretariat within 30 days of the name, postal address, telephone and telex numbers of the official who will be entrusted with the follow-up of the network (unless already indicated in Annex III). The secretariat will circulate this information.

21. The UNIDO secretariat will supply the national focal points with information before 30 August 1985 on the requirements for application of assistance from UNDP, IDB and World Bank.

22. National focal points will circulate among themselves and to the UNIDO secretariat the specific modules of indicative programme areas in regard to which they wish to participate in the network activities.

23. Participating countries will establish contacts among themselves and propose to the UNIDO secretariat not later than 31 December 1985 specific projects to be carried out within the scope of the network. UNIDO secretariat will contact appropriate funding agencies to enable the execution of the projects.

24. The meeting noted with appreciation the offer of Argentina to provide host facilities in Argentina for the next meeting of the network which is presently envisaged to take place in approximately 18 months.

II. REVIEW OF NATIONAL ACTIVITIES AND PLANS

25. The representatives of the countries present gave brief overviews of their national policies and plans in the field of microelectronics and indicated their interest in the proposed network both in terms of what they could expect from it and what they could contribute to it.

26. Brazil has been, for some considerable time, consciously developing national technological competence in the field of microelectronics. As early as 1967 strong research groups were built up in the universities in such fields as semiconductors, computer hardware and software, telecommunications systems etc. This technological capacity is seen as a source of, and support to, industrial development.

27. A range of wholly owned Brazilian companies have been established using this expertise and many of them have been successful. The National Policy Law for Informatics established in 1976 laid the basis for long-term development of the sector. A fundamental premise of this

policy is that the local industry develops its own technological expertise using what is called the "market reserve mechanism" to create conditions to develop national technology. For the most part the Policy Law can be said to have been successful and Brazil now has a healthy and growing national microelectronics industrial sector.

28. The newly formed National Microelectronics Institute is one of four institutes within the Technical Centre for Informatics. Its programme includes the following elements:

- design of ICs;
- processing of ICs (various chemical processes, mask making, encapsulation, characterization etc.).

Various processes are conducted at pilot scale and do not compete with industry. 30 per cent of the budget of the Institute is generated as fees for services.

29. There is also an activity producing silicon wafers, through the growth, cutting and polishing of silicon crystals.

30. Besides the Institute for Microelectronics of CTI, the R&D Center of Telebras in Campinas develops work in custom design of ICs for the telecommunications industry. There are nine university groups involved with research and teaching in microelectronics covering IC design, devices development, process for silicon and III-V compounds.

31. Three Brazilian companies produce integrated circuits. Itaucom started assembly and testing of bipolar and MOS digital ICs and is carrying out the design of ICs. SID Semiconductors is diffusing and assembling transistors and general-purpose integrated circuits, and started recently a group on IC design. Elebra Microelectronics is also offering IC design services. Aegis operates in the power devices area with local technology and production equipment developed by itself. Heliodinamica is a producer of four-inch silicon wafer and solar cells.

32. Brazil is open to regional co-operation in R&D. Bi- or multilateral co-operation could be envisaged provided the National Policy for Informatics was fully respected. Brazil wished to work on the basis of specific projects. The idea of a multi-project chip could be discussed.

33. Prior to 1981 the Mexican electronics industry consisted for the most part of the entertainment electronics sector and telecommunications. From 1981, however, Government policies have been progressively building up a strong professional electronics sector. The objectives of these policies are:

(i) to strengthen international competitiveness;
(ii) to promote national horizontal integration; and
(iii) to promote technological development.

34. These policies have been successful and many new enterprises - both companies with foreign investment and wholly owned national companies - are establishing themselves rapidly.

35. Significant research capacity is being built in the universities (Universidad Nacional Autónoma de Mexico (UNAM), Puebla, Polytechnic etc.) and in the research institutes (e.g. Instituto de Investigaciones Eléctricas (IIE), Instituto Mexicano de Petróle (IMP) etc.). A new electronics centre for technological support to industry is being created with the following functions:

- to strengthen design (of ICs, printed circuits etc.);
- to develop capacity for quality control; and
- to provide component and sub-assembly testing.

36. Regional co-operation could be important for Mexico in

- developing R&D strengths;
- developing a "critical mass" of sub-supply capacity.

37. Mexico is keen on engaging in co-operation activities through the proposed network and considers it highly opportune to initiate it so as to strengthen international competitiveness and avoid the higher costs of

later entry. It favours the creation of the proposed network but would wish it to be flexible and non-centralized. The multi-project chip could be discussed but a first priority would be to build up design capability. The Instituto de Investigaciones Eléctricas (IIE) in Cuernavaca would be the Mexican node for the network in the first instance.

38. The electronics industry started in the 1960s in Venezuela with assembly of such consumer products as TVs and radios. The consumer sector was consolidated in the 1970s and new national firms entered using foreign technology. In this period research was sponsored in the universities and in addition researchers were sent abroad for training. In 1979 the borders were opened to the importation of colour TVs and the local industry was substantially affected.

39. In the late 1970s highly trained Venezuelan engineers both from national universities and from abroad began to establish small firms in the professional electronics area. These firms number 10 to 12 today, have 100 per cent Venezuelan capital, and employ about 450 people, 120 of which are engineers with about 50 of these engaged in R&D.

40. The R&D activities in microelectronics in Venezuela are mainly concentrated in the Fundación Instituto de Ingeniería (FII), in various sectoral research institutes and in the universities. The FII is the most active of these and has a range of high technology research projects of industrial relevance in such fields as hybrid circuits, solar cells and power diodes.

41. Venezuela is anxious to explore the possibilities presented by regional co-operation in this field. It supports the proposed network and offers the FII as the node for the network.

42. Because of its economic circumstances little R&D in microelectronics has been undertaken in Jamaica. The urgent need is not so much to develop new technology and systems but to use existing equipment, systems and

technologies in an optimal way. There is clear scope for Jamaican software specialists to adapt the software products of the major suppliers to their special needs with consequent financial savings.

43. Jamaica has in the past benefited from international co-operation. It sees increasing scope for regional co-operation both in the Caribbean area and in Latin America. The proposed network could be of benefit in relation to:

- exchange of experience on policies in relation to the acquisition and use of computing systems;
- microelectronics applications projects; and
- software development.

44. A consumer electronics sector was established in Peru in the 1960s. Radios and TVs were assembled under protection. The sector grew substantially in the 1970s and attained an output of the order of 120,000 TVs and 300,000 radios. The component sub-supply sector was also substantial at this time. In 1980, however, the borders were opened to international competition and many of the local firms closed. In 1985 new provisions have been made which foresee, in the near future, the closing of the borders to the importation of radio and TV sets and components. It is expected that these measures will help to relaunch many firms in the consumer electronics area.

45. In the 1970s a number of small companies were established in the professional electronics and instrumentation sectors and they have survived and grown. A mechanism of collecting 2 per cent of the net profit of firms and investing it in research and development was employed. About 40 product developments were undertaken some of which are commercialized or are awaiting commercialization.

46. Projects of interest include:

- a small rural telephone switching system of 64 lines with direct national and international dialling; and
- the automation of existing rotary exchange systems thereby extending their useful life.

47. Peru was supportive of the concept of a network as proposed and suggested the following topics for consideration:

- R&D;
- systems and equipment; and
- applications of microelectronics.

The Instituto Nacional de Investigación Technológica Industrial y Normas Técnicas (ITINTEC) could be the node for the network.

48. Guatemala is at present more concerned with the application of microelectronics rather than new R&D. Applications areas of interest could be found in:

- agriculture and agro-industry;
- health;
- construction; and
- non-conventional energy sources.

49. The benefits Guatemala could see in the proposed network include:

- microelectronics applications;
- exchange of experience on policies for ensuring the better use of microelectronics;
- training of technical people abroad; and
- rural telephone exchange systems.

50. The electronics sector in Argentina suffered severely in recent years from the sudden opening of the borders to imports. The present Government seeks to remedy this situation and build again in Argentina a strong national information technology sector which would supply national needs and eventually be competitive internationally.

51. In 1984 a Commission on Informatics was established and it produced its policy proposals early this year. These proposals are currently before the legislature and are expected to be enacted soon. The objectives of the policy are broadly:

(i) to ensure the greater dissemination of the use of informatics addressing identified real national needs; and

(ii) to build up, over time, a national technological capacity capable of underpinning a nationally owned informatics technology industrial sector.

The policy is long-term in its perspective and global in its scope and comprises industrial development and software, R&D, training of human resources and applications in the public sector and in education.

52. On the industrial side a tender action was launched this year aimed at selecting specific companies in selected segments of the informatics sector for concentrated government support. The successful companies must show the capacity for innovation, must be owned and controlled in majority by Argentine nationals and must show capability in acquiring and applying the technology. A range of incentives will be available to selected firms including:

- financial incentives;
- tax incentives;
- tariff concessions; and
- public purchasing preference.

53. R&D in informatics in Argentina is conducted in some 50 research institutes, and involves about 900 professional scientists, engineers and technicians. These activities are co-ordinated through a national electronics development plan. Current microelectronics research activities include:

- pilot hybrid circuit plant;
- transistors and passives;
- CAD of ICs;
- semiconductor physics;
- microcomputer research;
- automatic control of industrial processes;

- basic software; and
- telecommunication equipment (including a rural telephony system now commercial).

It is intended to triple the budget for R&D in selected areas this year.

54. A technology monitoring group has recently been established with assistance from the IDRC and based on an agreement between the Subsecretariat of Informatics and Development and the Association for Technological Development (ADEST), with a view to identifying opportunities for Argentine initiatives. It is currently considering the following topics:

- custom/semicustom ICs;
- PABXs;
- computer numerical control equipment;
- supermicrocomputers; and
- electronic process control.

55. Argentina considers that co-operation between Latin American countries is not only desirable but essential because of the rapidity and scale of developments worldwide in the microelectronics field. The proposed network is fully supported. The national focal point is identified as the National Electronics Programme within the Subsecretariat of Informatics and Development. Potential areas for co-operation include technology monitoring, design of custom and semicustom chips and possibly rural telephony.

56. In 1968 Cuba produced its first prototype minicomputer and started its first R&D centre for microelectronics. Much attention was devoted in these years to developing education and training at all levels. This is now in place.

57. There are now 40-50 large or small groups dealing with electronics development. 15 of these are of greater importance and have national scope. Four groups are particularly strong in means and staff. A National Commission co-ordinates electronics activities. There is also a national body for the development of informatics and the technical aspects of manufacturing equipment for informatics.

58. Hundreds of each model of minicomputer have been produced and this will shortly be expanded to some thousands of units and large volumes of peripherals. The decision has been taken to stay with crossbar technology for telecommunications switching till 1990 and then to transfer to digital systems. The R&D centre for telecommunications is particularly strong.

59. The production of electronic components is now beginning and an IC and diode manufacturing plant is now in operation. All phases including design, maskmaking and all later stages are available. It is the intention to proceed to the massive production of ICs and discretes. Training at all levels was provided. A factory to produce monocrystal silicon is now being built.

60. Cuba would welcome regional co-operation with Latin American countries. It believes, for example, that there is much scope for purchasing raw materials and some equipment in the region rather than, as at present, from Europe.

61. Cuba is in agreement with and strongly supportive of the proposed network as suggested in the UNIDO documents. It could offer:

- experience in specialized assembly techniques; and
- training of human resources at all levels (Cuba is willing to analyze the possibility of the creation of a centre for personnel training which it could put at the service of the region if this would be welcomed).

Cuba offers the Centro Científico Técnico associated with the development of raw materials and electronic components as the node for the proposed network.

62. Observers from RITLA, JUNAC, IDRC and IBI gave and account of those activities of their organizations which would be of particular relevance to the network. REMLAC's information activities will be of relevance to RITLA. JUNAC is compiling an inventory of software acquired and adapted or produced in its member countries. It could share this information with

the proposed network. IDRC is supporting research on information technologies in the region, for example, a study on the Argentine electronics industry, and work on international technological trends, both done by local researchers in Argentina. IBI is in the process of establishing two networks in the region which would be of relevance to REMLAC and close links could be established among them and with UNIDO and SELA.

63. The representative of CARIRI stated that small countries in the region placed much reliance on REMLAC which he hoped would pay due attention to their needs. As a result of the network discussions he intended to make a strong recommendation to his Government (Trinidad and Tobago) to join the network and also to formulate a national policy on microelectronics.

64. Recalling the conclusions of a meeting of UNDP Resident Representatives in Santo Domingo, Dominican Republic in November 1984, the representative of UNDP stated that UNDP attached high importance to strengthening technological capabilities in high technology in the region and will consider funding some preparatory assistance in 1986 and a regional project for the next programming cycle 1987-1991.

III. SOME INITIAL ISSUES FOR DISCUSSION

65. Views were exchanged on selected issues, as an initial network acitivity.

Government Policies for the Data Processing Industries

66. In general terms, the public policies that have been formulated in the region in recent years seem to reflect:*/

(a) The recognition of the importance of what is called "the electronic complex" or "the information technologies" whose technological core is microelectronics and associated technologies;

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*/ Presentation of UNIDO document ID/WG. 440/7.

(b) The problems and possibilities that the development of those technologies pose to the socio-economic development of the region; and

(c) A critique of the import substitution oriented pattern of industrialization that was predominant in the region from the post-war period until the last decade.

67. The last point (the response to the weakness of the import substitution model) is even an explicit goal in some of the legal documents that formulate the policies (such as those of Mexico or Argentina). In any event there is a need to guard against the repetition of some of the undesirable features of that pattern of industrialization.

68. Some examples of the possibility of repeating past mistakes were introduced into the discussion:

(a) The fact that most of the policies - with the exception of the Brazilian one - were formulated as the imports of electronic goods began to increase;

(b) The priority given to certain sectors of the industry - like microcomputers - which seem to indicate that the predominant factor influencing decisions was the dynamics of imports or external markets;

(c) The relatively low attention that capital goods receive in the policies reviewed. In other words the production and use of CAD, CAE, CAM or testing systems have been less emphasized than the fabrication of the products in which these systems and equipment have an increasingly important role;

(d) The difficulties that will be faced in assuring the technology-transfer process to the joint-ventures which are promoted by some of these policies. On this point, it was emphasized that the success of the technological transfer process depends to a great extent on the orientation and capabilities of the local partners.

69. It was also observed that the problem of interaction between R&D centres and universities, on one hand, and industry on the other, is mainly caused by the scarce demand for technology from firms. This is in turn the typical behaviour of firms which were formed and developed in mature, low technology branches of activity, characteristic of an import substitution oriented industrialization.

70. On the whole, policy-makers are aware of these questions. The behaviour patterns that firms acquired during the Latin American industrialization pattern of the last decade, however, represent serious difficulties which must be solved if a new industrial and technological pattern is to be developed which adequately addresses the regional needs and potentialities of the next decades.

The interrelation between microelectronics and telecommunications in Latin America

71. The points made in the presentations by consultants*/ and subsequent discussion include:

(a) The change in telecommunications systems from electromechanical technology to digital technology (digital electronic hardware, plus software control is proceeding rapidly throughout the region);

(b) As a result telecommunications is moving away from being merely an infrastructure to being a stimulus and facilitator of progress in an entire "information technology revolution".

(c) It was emphasized that the convergence of telecommunications technology and microelectronics is leading to significant opportunities for developing countries to enhance their local microelectronics technology capacities and their local microelectronics industries. The use of the public purchasing power of local telecommunications authorities would be important in this regard;

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*/ Documents ID/WG.440/2 by M. Hobday and ID/WG.440/11 by S. Wajnberg.

(d) The fierce international competition that exists between the major telecommunication equipment suppliers offers an opportunity for developing countries to drive a hard bargain with their suppliers. The elements of such a bargain could include:

- a favourable price;
- low-interest loans;
- local manufacture; and
- local technological development.

(e) The Latin American market for digital switching equipment is large in world terms accounting for 16.7 per cent of the world market. The uncommitted markets of the developing countries are extremely important to the major multinational suppliers.

(f) The "telematics" market of equipment to be connected to the network and new services to be offered over the network is rapidly growing, it will become very large, and will offer great opportunities to local industry with appropriate expertise;

(g) The experience of Brazil*/ in telecommunications offers an example of what is possible in this field in Latin America. In the early 1970s Brazil set itself two objectives:

(i) To build a modern efficient telecommunications infrastructure; and

(ii) To establish a strong industrial base in (digital) telecommunications technology.

A large and well resourced telecommunications R&D centre was established and undertook a wide range of research and development activities. The objectives of this policy are being largely met.

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*/ As contained in UNIDO document ID/WG.440/11 by S. Wajnberg.

(h) In 1983 the Brazilian electronics equipment production reached US$ 3.7 billion which originated a demand of US$ 190 million in semiconductors. Local semiconductor manufacture has succeeded in supplying more than half of the demand;

(i) Recent trends in technology are leading to the integration of more functions on a single chip. Equipment design is progressively merging with chip design. As a result, Brazilian industry is now becoming progressively more dependent on foreign technology due to the increasing use of custom chips in modern equipment;

(j) Trained high-level manpower is now becoming a major bottleneck in this area. The relevant human resources in Brazil, significant as they are in a Latin American context, are insufficient to meet the challenge of the custom or semi-custom chip. Co-operation within the Latin American region is, as a consequence, not just desirable - it is a necessity.*/

The use of public purchasing as a tool to develop technological competence in microelectronics**/

72. The discussion laid emphasis on the following points:

(a) Governments through their various agencies (e.g. telecommunications authorities, energy utilities etc.) spend very large sums of public money every year purchasing microelectronics-based equipment to provide public services;

(b) This large purchasing power can be used by governments to develop their local technological competence and also their local industries.

(c) There are, however, a number of preconditions which it is desirable to meet to ensure that such policies are successful. The preconditions include:

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*/ Document ID/WG.440/11 by S. Wajnberg.

**/ Document ID/WG.440/1 by E. Lalor.

(i) The provision of adequate and timely information;

(ii) Unbundling contracts and assistance in the building of consortia;

(iii) Giving direct technical assistance to the suppliers; and

(iv) Funding development contracts with potential suppliers.

(e) In the Latin American region, where at the moment financial resources for technological development are scarce, public purchasing is agreed to provide a major opportunity for local microelectronics development because:

(i) The funds that are being committed to these purchases are very large; and

(ii) They are controlled by governments.

What is needed is the understanding by decision-makers of the opportunity and the requirements for success, and the determination to follow through by all concerned.

(f) The experience of Venezuela whose telephone company has just issued a call for tenders for one million lines will be watched with interest. It appears that the telephone company is explicitly open to the promotion of local enterprise and technology developments in this connection; and

(g) One technology policy instrument which has been pursued by the Andean Group is that of "technology unpacking or disaggregation". This approach proved to be quite successful when applied to the petrochemical sector. Five full projects in this sector were disaggregated and local producers or suppliers were identified. A similar approach has been suggested for a plan which is now being discussed - the Andean communications satellite which is expected to be launched by the end of the decade. Local suppliers of equipment and components which can contribute to the development of the project have already been identified.

Annex I

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Annex II

LIST OF DOCUMENTS

		Language
	Aide-Mémoire	E S
ID/WG.440/1	The Use of Public Purchasing as a Tool to Develop Technological Competence in Microelectronics prepared by E. Lalor	E S
ID/WG.440/2	Telecommunications and Information Technology in Latin America: Prospects and Possibilities for Managing the Technology Gap prepared by M. Hobday	E S
ID/WG.440/3	Proposed Structure of the Regional Network for Microelectronics in the ECLAC Region prepared by the UNIDO secretariat	E S
ID/WG.440/4	Some Considerations on the Content and Modalities of a Programme of Work for REMLAC prepared by the UNIDO secretariat	E S
ID/WG.440/5	Research and Development in Microelectronics in Argentina, Brazil, Mexico and Venezuela prepared by G. Fernández de la Garza	E S
ID/WG.440/6	Report on the UNIDO Mission Preparatory to the Establishment of a Regional System for Microelectronics in Latin America (REMLAC) prepared by G. Fernández de la Garza and M. Octavio	E S
ID/WG.440/7	Government Policy for the Data-Processing Industries in Argentina, Brazil and Mexico prepared by H. Nochteff	E S
ID/WG.330/8	Provisional Agenda	E S
ID/WG.440/9	Annotated Provisional Agenda	E S
ID/WG.440/10	List of Documents	E S
ID/WG.440/11	Approach to Regional Microelectronics Co-operation Programme	E S

BACKGROUND PAPERS

UNIDO/IS.444	A Silicon Foundry to Service Developing Countries' Needs: A Preliminary Approach prepared by the UNIDO secretariat	E

UNIDO/IS.526	Survey of Government Policies in Informatics prepared by the UNIDO secretariat	E
UNIDO/IS.529	The UNIDO Programme on Microelectronics: An Analytical Perspective prepared by R. Narasimhan	E S
ID/WG.372/17	Report of UNIDO/ECLA Expert Group Meeting on Implications of Microelectronics for the ECLA Region Mexico City, 7-11 June 1982	E S
	Microelectronics Monitor	
	Issue No. 10/11: April - September 1984	E
	Issue No. 12: October - December 1984	E
	Issue No. 12 Supplement: December 1984	E

Annex III

ADRESSES OF REMLAC FOCAL POINTS

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